HL Acid-Base Review MS (2011 Exam)

1. B **(7)**
2. B **(6)**
3. C/D **(4)**
4. A **(3)**
5. B **(5)**
6. B **(5)**
7. A **(5)**
8. C **(5)**
9. A **(6)**
10. D **(5)**
11. C **(4)**
12. B **(6)**
13. C **(5)**
14. A **(5)**
15. D **(5)**

Legend		**Free Response Section (Paper 02)**												
Level:	Needed	Grade	Possible	3		4		5		6		7		Cutoff
Above +6	0%	**2**	0	70%	0	50%	1	30%	7.8	20%	1	10%	0.4	**10**
Above +5	10%	**3**	0	80%	0	70%	1.4	50%	13	30%	1.5	20%	0.8	**17**
Above +4	20%	**4**	2	90%	0	80%	1.6	70%	18.2	50%	2.5	30%	1.2	**24**
Above +3	30%	**5**	26	100%	0	90%	1.8	80%	20.8	70%	3.5	50%	2	**28**
Above +2	50%	**6**	5	100%	0	100%	2	90%	23.4	80%	4	70%	2.8	**32**
Above +1	70%	**7**	4	100%	0	100%	2	100%	26	90%	4.5	80%	3.2	**36**
Level	**80%**	**Multiple Choice Section (Paper 01)**												
Below -1	90%	Grade	Possible	3		4		5		6		7		Cutoff
Below -2	100%	**2**	0	70%	0.8	50%	1	30%	2.4	20%	0.6	10%	0.1	**5**
Below -3	100%	**3**	1	80%	0.8	70%	1.4	50%	4	30%	0.9	20%	0.2	**7**
Below -4	100%	**4**	2	90%	0.9	80%	1.6	70%	5.6	50%	1.5	30%	0.3	**10**
Below -5	100%	**5**	8	100%	0.9	90%	1.8	80%	6.4	70%	2.1	50%	0.5	**12**
Below -6	100%	**6**	3	100%	1	100%	2	90%	7.2	80%	2.4	70%	0.7	**13**
Below -7	100%	**7**	1	100%	1	100%	2	100%	8	90%	2.7	80%	0.8	**15**

16. (a) **(4x1)** $CH_2ClCOOH \rightleftharpoons CH_2ClCOO^- + H^+$; 1

Ignore state symbols, accept □ and equation for the reaction with water.

(b) **(5x1)** $(K_a) = \dfrac{[CH_2ClCOO^-][H^+]}{[CH_2ClCOOH]}$; 1

ECF from (a) if charge(s) missing in equation.

(c) **(5x1)** 1.38×10^{-3}; 1

Accept answer in range 1.3 to 1.4×10^{-3}, ignore units.

(d) **(5x1)** ethanoic < iodoethanoic < chloroethanoic; 1

[4]

17. (i) **(5x1)** acidic;

(5x1) $Fe(H_2O)_6^{3+}$ is a weak acid/Fe^{3+} reacts with OH^-/equation to show formation of HCl or H^+;

"$FeCl_3$ is acidic" is not acceptable. 2

(ii) **(5x1)** neutral;

(5x1) $NaNO_3$ / sodium nitrate is formed from strong base and strong acid/ions do not hydrolyse; 2

(iii) **(5x1)** alkaline;

(5x1) As CO_3^{2-} is weak base/combines with H^+/equation showing formation of OH^-; 2

Acidic, neutral, alkali mark in each case is independent of reason.

[6]

18. (i) **(5x1)** not a buffer;

(6x1) after reaction, contains 0.10 mol NH_4Cl + 0.10 mol HCl/ weak acid + strong acid/a strongly acidic solution/not a weak acid-conjugate base combination; 2

Do not award any marks if stated "a buffer solution".

(ii) **(5x1)** a buffer;

(6x1) after reaction, contains 0.10 mol NH_3 + 0.10 mol NH_4Cl/ a weak acid and conjugate base; 2

Do not award marks if stated "not buffer solution".

[4]

19. (a) (i) **(5x1)** pK_a = 3.75, therefore $K_a = 1.78\times10^{-4}$ (accept 1.8×10^{-4}) 1

No units required.

(ii) **(5x1)** weak acid;

(5x1) less $[H^+]$/partial dissociation/more reactants/less products/ K_a << 1/small K_a; 2

(iii) ($HCOOH(aq) \rightleftharpoons H^+(aq) + HCOO^-(aq)$)

(5x1) $K_a = \frac{[H^+][HCOO^-]}{[HCOOH]} = \frac{x^2}{0.010}$;

($x^2 = 1.78\times10^{-6}$)

(6x1) $x = 1.33\times10^{-3}$ mol dm^{-3} = $[H^+]$ (*no mark without units*);
ECF from (a)(i).
No penalty for incorrect significant figures.

(5x1) pH = 2.88/2.9 *(ECF)*;

(6x1) assume x << 0.010/25°C/negligible dissociation; 4

(b) **(5x1)** add strong base/sodium hydroxide or other named alkali/salt of methanoic acid/HCOONa to methanoic acid;

(6x1) in equimolar amounts/quantities/so that [HCOOH] = $[HCOO^-]$;

(7x1) (from K_a expression) pH = pK_a (= 3.75); 3

[10]

20. (a) **(4x1)** (K_w =)$[H^+][OH^-]$; 1

(b) **(5x3)** $[H^+] = \sqrt{K_w} / \sqrt{5.60\times10^{-14}}$;

$= 2.37\times10^{-7}$ (mol dm^{-3}) 3

(accept 2.3 – 2.4×10^{-7}*, no significant figure penalty);*
pH = 6.6 *(accept* 6.60 – 6.63*, no significant figure penalty);*

(c) **(5x1)** $[H^+]$ = $[OH^-]$ / concentrations or amounts or numbers of;

H^+ and OH^- are the same; 1

Do not award mark if reference to H^+ and OH^- or ions.

[5]

21. (a) **(5x1)** $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

Accept correct equation with NH_4OH instead of NH_3.

. **(7x1)** mol H_2SO_4 = 0.0201×0.150;

(7x1) $2NH_3 = H_2SO_4$/mol $NH_3 = 6.03\times10^{-3}$;

(7x1) $[NH_3]$ = 0.241 (mol dm^{-3}); 4

Apply –1(SF) if appropriate.
*Award **[3]** for the correct final answer for the concentration calculation.*

(b) **(5x1)** $K_b = 10^{-4.75} = 1.78\times10^{-5}$;

(5x1) $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$ /$[OH^-] = \sqrt{K_b[NH_3]}$;

(5x1) $[OH^-] = \sqrt{1.78\times10^{-5}\times0.121}$;

(5x1) pOH = 2.83; 4

*Award **[4]** for the correct final answer.*

Allow ECF, for example any correct conversion of $[OH^-]$ to pOH.

[8]